DOCUMENT RESUME

ED 141 353 SP 011 245

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TITLE A Study of Needs for Further Learning as Seen by Teachers of Secondary School Mathematics.
NOTE 20p.

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS Inservice Programs; *Inservice Teacher Education; *Mathematics Teachers; *Needs Assessment; Program Development; *Secondary School Teachers; *Teacher Attitudes
IDENTIFIERS Minnesota

ABSTRACT

This document reports responses to a questionnaire investigating the needs of junicr and senior high school mathematics teachers in Minnesota for cortinued inservice education programs. The questionnaire, administered to two hundred and seventy-eight teachers in both rural and urban public schools, posed seventy-two questions cn the usefulness to them of further study in mathematics and mathematics pedagogy. Respondents were also asked to review the questicns and responses and to select and rank the ten most important. The greatest need for further study as perceived by the teachers was in the area of instructional processes (communication, motivatien, interest arousal, etc.) rather than mathematics content course offerings. Questionnaire and data summaries are included in the report. (MB)

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ED141353

A Study of Needs for Further Learning as Seen by Teachers of Secondary School Mathematics

by Dean Hendrickson and Milt Virant

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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Statement of the Problem

What topics of study do secondary teachers of mathematics consider timely and relevant to their teaching assignments?

Introduction

Teacher certification in the State of Minnesota has gradually moved in the direction of stimulation of continuing growth and self-improvement on the part of teachers. As of July, 1973, teachers must renew their continuing certificates every five years by presenting evidence of one year's successful teaching experience and of having earned 120 renewal units. These are granted by a local evaluation committee for college course work, attendance at professional meetings, supervision of student teachers and similar activities. Additionally, teachers certified to teach after September 1, 1966, with a minor, as in mathematics for example, must upgrade the minor to a major within seven years in order to have certification continued.

These regulations place a heavy responsibility on teacher education programs for the development of graduate course offerings that teachers see as relevant to their classroom assignments. Such courses must be more than merely responsive, however; they must also be inspirational, thought-provoking, with specific suggestions for ways to meet needed changes and for introduction of useful methods and techniques.

SP011 245

Mathematics educators in higher education must develop instructional packages of different kinds to present for consideration by those planning in-service activities to meet particular school system needs. In doing so, the needs for further study as identified by the teachers themselves must serve as the basis for designing these activities.

Methods and Procedures

To help the University of Minnesota, Duluth, develop its continuing education program for mathematics teachers, a questionnaire was sent to 278 teachers of junior high school and high school mathematics in northeastern Minnesota. This area includes a major urban center, Duluth, the cities of the taconite and iron ranges, and a large rural area. The schools ranged in size from 150 students 7-12 to 3000 students 7-12.

In addition to items designed to acquire demographic data, the questionnaire included 72 items of the Likert type. (See Appendix I) The purpose was to have them judge how immediately useful to them, in their existing classroom situation, further study of different topics in mathematics and mathematics pedagogy would be, 26 of the items related to teaching methods, techniques, materials of instruction and similar pedagogical ideas, while the remaining 46 were grouped under the major headings of geometry, algebra, pre-calculus analysis, calculus, advanced calculus, computer science, probability and statistics, logic and number theory.

Respondents were also asked to, after having completed all items; go back and select the ten most important of all the items and rank order them.

Results

A total of 140 teachers returned completed questionnaires. Table 1 summarizes their characteristics. Responses were broken down by subjects taught, years of experience and degrees held. A SPSS (Statistical Package for the Social Sciences) computer program was used to find means, medians, ranges, and frequency distributions. (Insert Table 1 here.)

In deciding what kinds of course offerings would be most valuable to teachers, identification of the particular topics they considered most important was of interest. Teachers of all subjects, all experience levels, and all training levels showed surprising agreement: Mentioned as most important in decreasing order of frequency (frequency in parenthesis) are:

1. Techniques for motivation (31)
2. Providing for slow learners (13)
3. Applications of mathematics (12)
4. Classroom management, including discipline (5)
5. Using the computer (5)
6. Special methods for a particular subject (such as algebra, etc.) (9)
7. How mathematics learning takes place (3)
8. Using instructional aids (3)
9. Improving curriculum offerings (2)
10. How to individualize instruction (2)

As shown in Table 4, however, these rankings were slightly different for junior high school and high school teachers. Only one-third of the respondents teach in high school only, 49 percent teach in junior high school only and the remainder teach in both.

A slightly different ordering of these topics, but within the same top-rated topics, is obtained when tallying how many times each was mentioned as one of the top three ranked topics.

1. Motivation (53)
2. Providing for Slow Learners (36)
3. Arithmetic Methods (19)
4. Computer Use (18)
5. Algebra Methods (15)
6. Discipline (14)
7. Applications (14)
8. Learning (13)
9. Curriculum Improvement (10)
10. Individualizing Instruction (9)

    How to Use Instructional Aids (9)

Breakdowns by experience level and training level show percentages rating each topic first as shown in Table 2 and as one of the top three as shown in Table 3. (Insert Tables 2 and 3 here.)

Breakdown by subject taught shows percentages rating each topic among top three as shown in Table 4. Table 5 gives a summary of which subject teachers rated the most frequently mentioned topics highest.

(Insert Table 5 here.)

The top ranking of all 72 items by the median ratings given them is summarized in Table 6. The only mathematics topics that had median ratings above 4.0 were linear functions, polynomial functions, systems of equations by both Algebra I and Algebra II teachers; matrix algebra, trigonemetric functions, logarithmic functions, mathematical induction, exponential functions by Algebra II and pre-calculus analysis teachers; special topics in geometry by geometry teachers.

(Insert Table 6 here.)

Comparison of responses, where they differed greatly, by teachers with bachelor's degrees and master's degrees indicated those with the master's degree seemed more interested in the use of computer, in special methods in the subjects taught. Those with the bachelor's degree had greater interest in psychology of learning, use of instructional aids and in use of questioning techniques.

Comparison of responses, where they differed greatly, by experience levels indicated the less experienced were more concerned with discipline and classroom management, motivation techniques and how learning occurs than those with more experience.

High school teachers of traditional college preparatory subjects tended to be more concerned with finding applications, individualizing instruction and providing for the gifted than were the junior high school teachers. Junior high teachers tended to be either inexperienced or with the greatest amount of experience.

Conclusions:

1. Teachers of all subjects are interested in learning more about techniques and materials specific to that subject, than in the general pedagogical concerns ranked in Table 1.

2. As experience is acquired, classroom management and discipline concerns tend to decrease and interest in providing for individual differences increases.

3. Junior high school teachers are more concerned with motivation, ways to help slow learners; with applications and maintaining classroom control. High school teachers still find motivation a problem, but applications, innovations such as use of the computer and providing for individualizing

of instruction tend to replace classroom management and work with slow learners as concerns.

4. Teachers generally have little interest in the history of mathematics, in further study of more advanced topics in calculus, statistics, game theory, etc.

5. More interest is shown in computer work, especially BASIC programming by those with more experience and training.

6. Of particular importance to UMD are the following:

A majority of teachers in the area teach at least one arithmetic class.

More graduates from other institutions teach in the area than do UMD graduates.

Recommendations

The greatest need for further study as seen by in-service teachers is in the area of the instruction process--communicating, motivating, arousing interest, guiding learning activities, etc. It is not for more mathematics content courses offerings to teachers should deal with methods, techniques, psychology, materials of instruction, applications and providing for individual differences, especially the needs of slow learners.

Although the sample used came from a restricted region of NE Minnesota, the ranges in population density from rural to urban, in school size and undergraduate origin of the teachers responding are not essentially different from those anywhere in Minnesota, the Midwest or the Nation. The results of this study should be useful to higher education institutions and school systems everywhere in planning for continuing professional development of mathematics teachers.

Table 1

Demographic Data of Respondents

Classification	Number	% of Total	Median Years Experience
Questionnaires sent out	278		
Questionnaires returned	140	50.35%	11
Teachers with 1-3 years experience	25	18.5%	
Teachers with 4-8 years experience	28	20.7%	
Teachers with 9-14 years experience	47	34.8%	
Teachers with 15-20 years experience	18	13.3%	
Teachers with 20 + years experience	17	12.6%	
Teachers with baccalaureate as highest degree held	84	60.4%	8.9
Teachers with master's as highest degree held	55	39.6%	14.3
UMD Graduates	41	29.3%	11.1
Non-UMD Graduates	99	70.7%	10.9
Teach Senior High School Only	46	33%	
Teach Junior High School Only	69	49%	
Teach Both Junior and Senior High School	25	18%	
Presently teaching Arithmetic	84	60%	
Presently teaching Algebra I	63	45%	
Presently teaching Algebra II	34	24%	
Presently teaching Geometry	51	36%	
Presently teaching Precalculus Analysis	19	13.6%	
Presently teaching Computer Programming	11	7.9%	
Presently teaching Calculus	5	3.6%	
Presently teaching Trigonometry	24	17%	
Presently teaching Matrix Algebra	5	3.6%	

Table 2

Most Frequently Mentioned as Most Important

		Experience in Years					Highest Degree	
	All	1-3	4-8	9-14	15-20	21+	Bachelors	Masters
Motivation	N=31 22%	9 36%	6 21%	11 23%	2 11%	2 11.8%	21 25%	10 18%
Slow Learners	13 9%	1 4%	3 10.5%	4 8.5%	2 11%	3 17.6%	7 8.3%	6 10.9%
Math Applications	12 8.6%	3 12%	1 3.6%	6 12.8%	1 5.5%	0 0	4 4.8%	12 21.8%
Classroom Management Discipline	5 3.6%	2 8%	1 3.6%	1 2%	0 0	1 5.9%	2 2.4%	1 1.8%
Computer Use	5 3.6%	0 0	0 0	2 4%	1 5.5%	2 11.8%	1 1.2%	4 7.2%
Subject Methods	9 6.4%	3 12%	3 10.7%	3 6.4%	2 11%	0 0	4 4.8%	2 3.6%
Learning	3 2.2%	0 0	2 7.1%	1 2%	0 0	0 0	3 3.6%	0 0
Other 65 Topics	44%	7 28%	13 46%	19 40%	8 44%	9 53%	42 50%	20 36.4%

Table 3

Times Mentioned in Top Three

	All	Experience in Years					Highest Degree	
		1-3	4-8	9-14	15-20	21+	Bachelors	Masters
Motivation	53 37.9%	15 66%	12 42.9%	18 38.3%	2 11%	5 29.4%	34 40.5%	19 34.5%
Slow Learners	36 25.7%	13 42%	6 21.5%	10 21.3%	3 16.7%	4 23.5%	25 29.8%	11 20%
Special Methods	34 24.3%	7 28%	12 42.9%	11 23.4%	6 33%	0 0	21 25%	13 23.6%
Computer Use	18 12.9%	1 4%	1 3.6%	7 14.9%	4 22%	4 23.5%	4 4.8%	14 25.5%
Discipline	14 10%	5 20%	4 14.3%	3 6.4%	0 0	2 11.8%	11 13.1%	3 5%
Applications	14 10%	5 20%	4 14.3%	9 19.1%	4 22%	3 17.6%	14 16.7%	12 21.8%
Learning	13 9.3%	0 0	3 10.7%	7 14.9%	1 5.6%	2 11.8%	9 10.7%	4 7.2%

Table 4

Some of the Most Frequently Mentioned in the Top Three
In Importance, By Subject Taught

	Arithmetic	Algebra I	Algebra II	Geometry	Trigonometry	Precalculus
Motivation	37 44%	19 30.2%	8 23.5%	10 19.6%	4 16.7%	5 26.3%
Slow Learners	31 36.9%	12 19%	2 5.9%	8 15.7%	1 4.2%	0 0
Special Methods	19 33%	11 17.5%	4 11.8%	8 15.7%	1 4.2%	4 21.1%
Applications	13 15.5%	12 19%	8 23.5%	12 23.5%	6 25%	3 15.8%
Discipline	11 13.1%	6 9.5%	2 5.9%	2 3.9%	1 4.2%	1 5.3%
Gifted	9 10.7%	7 11.1%	1 2.9%	3 5.9%	1 4.2%	0 0
Curriculum Improvement	8 9.5%	6 9.5%	2 5.9%	4 7.8%	1 4.2%	0 0
Learning	8 9.5%	5 7.9%	1 2.9%	5 9.8%	0 0	0 0
Coordinating with Other Subjects	8 9.5%	5 7.9%	0 0	2 3.9%	0 0	0 0
Individualizing Instruction	7 8.3%	5 7.9%	4 11.8%	5 9.8%	3 12.5%	0 0
Computer Use	7 8.3%	9 14.3%	7 20.6%	6 11.8%	6 25%	7 36.8%

Table 5

Areas of Greater Concern of Subject Area Teachers

	Item	Teachers Rating Highest
1	Techniques for motivation	Arithmetic
2	Providing for slow learners	Arithmetic
3	Providing for the gifted	Geometry
4	Improving curriculum offerings	Trigonometry
5	Using instructional aids useful in math	Algebra I
6	How math learning occurs	Trigonometry
7	Classroom management techniques-discupline	Arithmetic
8	How to individualize instruction	Trigonometry
9	Questioning techniques--Facilitating discovery	Arithmetic
10	Coordinating math with instruction in Science, Art, etc.	Arithmetic
11	Defining better goals and objectives	Geometry
12	Application of mathematics	Algebra II

After analyzing the median results of all items and classifications it was felt that three of these classifications would be most important and representative of teacher responses.

Table 6

Top 15 Ranked Items as Indicated by Median Weights Assigned

All Teachers

	Item	Median	T Median
1	Techniques for motivation	6.133	
2	Application of mathematics	6.029	
3	Providing for slow learners	5.467	
4	Using the computer to teach math	5.200	
5	Coordinating math with Science, Music, etc.	5.133	
6	How to Individualize Instruction	5.083	
7	Knowledge of new curriculum projects	4.900	
8	Providing for the gifted	4.758	
9	*Linear Functions*	4.500	5.563 Alg I 5.300 Alg II
10	Questioning techniques	4.464	
11	Knowledge of references	4.446	
12	How math learning occurs	4.438	
13	Arithmetic methods	4.364	5.500 Arith
14	Algebra methods	4.357	5.458 Alg I 4.786 Alg II
15	Using instructional aids	4.348	

LEGEND:

METHODS ITEMS: Regular Type
MATHEMATICAL COMPETENCE ITEMS: Italicized
T MEDIAN: MEDIAN RESPONSE OF THOSE CURRENTLY TEACHING THAT PARTICULAR ITEM.

KEY:

Scale 1-2-3-4-5-6-7

1 = Least Important

7 = Most Important

APPENDIX A

How many years have you taught mathematics? _____

What grades do you teach this year? (circle) 7 8 9 10 11 12

What subjects do you teach? (circle) Arithmetic Algebra I Algebra II Trigonometry Precalculus Analysis Calculus Probability and Statistics Matrix Algebra Computer Programming Geometry: kind _____

Other _____

Are you a UMD graduate? (circle) yes no

What is the highest degree you hold? (circle) Bachelors Masters Doctorate

Some other questions of interest to us include:

What would most help you to better teach the mathematics classes you teach?

How up-to-date are you in your knowledge of new materials of instruction and programs in mathematics for schools?

What additional mathematics do you need to know to teach the classes you teach?

The following items will help us find answers to these questions. For each item place a mark in the space to the right of that item to best describe the importance of that item to your teaching NOW. 7 rates the item as most important or most needed, 1 rates the item as least important or not needed. Consider what you need AT THIS TIME, not what you might have liked in your undergraduate work. At the end of each section is space for you to write in any topics you feel should have been included.

I METHODS

		7	6	5	4	3	2	1	
_____ 1.	Techniques for motivation	"	"	"	"	"	"	"	(1)
_____ 2.	Providing for slow learners	"	"	"	"	"	"	"	(2)
_____ 3.	Providing for the gifted	"	"	"	"	"	"	"	(3)
_____ 4.	Improving curriculum offerings, e.g. How to develop new courses	"	"	"	"	"	"	"	(4)
_____ 5.	Using instruction aids useful in math, e.g. geoboards	"	"	"	"	"	"	"	(5)
_____ 6.	Special techniques for introducing topics in arithmetic	"	"	"	"	"	"	"	(6)
_____ 7.	Special techniques for introducing topics in algebra	"	"	"	"	"	"	"	(7)
_____ 8.	Special techniques for introducing topics in geometry	"	"	"	"	"	"	"	(8)
_____ 9.	Special techniques for introducing topics in trigonometry	"	"	"	"	"	"	"	(9)
_____10.	Special techniques for introducing topics in pre-calculus analysis	"	"	"	"	"	"	"	(10)

		7	6	5	4	3	2	1	
____11.	Special techniques for introducing topics in calculus	"	"	"	"	"	"	"	(11)
____12.	Special techniques for introducing topics in _____	"	"	"	"	"	"	"	(12)
____13.	How to evaluate instruction	"	"	"	"	"	"	"	(13)
____14.	How mathematics learning occurs	"	"	"	"	"	"	"	(14)
____15.	Classroom management techniques including discipline	"	"	"	"	"	"	"	(15)
____16.	Questioning techniques, e.g., facilitating discovery	"	"	"	"	"	"	"	(16)
____17.	How to individualize instruction	"	"	"	"	"	"	"	(17)
____18.	Knowledge of new curriculum projects	"	"	"	"	"	"	"	(18)
____19.	Knowledge of references, other sources of ideas about teaching	"	"	"	"	"	"	"	(19)
____20.	Using the computer to teach math	"	"	"	"	"	"	"	(20)
____21.	Use of educational technology such as filmstrips, film loops, videotape	"	"	"	"	"	"	"	(21)
____22.	Coordinating mathematics with instruction in science, art, music, etc.	"	"	"	"	"	"	"	(22)
____23.	Defining better goals and objectives	"	"	"	"	"	"	"	(23)
____24.	Application of mathematics	"	"	"	"	"	"	"	(24)
____25.	History of mathematical thought	"	"	"	"	"	"	"	(25)
____26.	Evaluating materials of instruction, texts, etc.	"	"	"	"	"	"	"	(26)
____27.	_____ _____	"	"	"	"	"	"	"	(27)
____28.	_____ _____	"	"	"	"	"	"	"	(28)

II MATHEMATICAL COMPETENCE

____ 1.	Geometry	"	"	"	"	"	"	"	(1)
____	(a) Euclidean	"	"	"	"	"	"	"	(a)
____	(b) Transformational	"	"	"	"	"	"	"	(b)
____	(c) Coordinate, vectors	"	"	"	"	"	"	"	(c)
____	(d) Non-Euclidean, finite, etc.	"	"	"	"	"	"	"	(d)
____	(e) _____	"	"	"	"	"	"	"	(e)
____ 2.	Algebra	"	"	"	"	"	"	"	(2)
____	(a) Linear functions	"	"	"	"	"	"	"	(a)
____	(b) Polynomial functions, e.g., conic sections, etc.	"	"	"	"	"	"	"	(b)
____	(c) Systems of equations, inequalities	"	"	"	"	"	"	"	(c)

		7	6	5	4	3	2	1	
____	(d) Mathematical systems, e.g., groups, rings, fields	"	"	"	"	"	"	"	(d)
____	(e) Matrices, determinants	"	"	"	"	"	"	"	(e)
____	(f) _____	"	"	"	"	"	"	"	(f)
____	3. Pre-calculus analysis	"	"	"	"	"	"	"	(3)
____	(a) Trigonometric functions	"	"	"	"	"	"	"	(a)
____	(b) Logarithmic functions	"	"	"	"	"	"	"	(b)
____	(c) Exponential functions	"	"	"	"	"	"	"	(c)
____	(d) Mathematical induction	"	"	"	"	"	"	"	(d)
____	(e) Complex Numbers, inc. Polar Coordinates	"	"	"	"	"	"	"	(e)
____	(f) Sequences and series	"	"	"	"	"	"	"	(f)
____	(g) _____	"	"	"	"	"	"	"	(g)
____	4. Calculus	"	"	"	"	"	"	"	(4)
____	(a) Limits	"	"	"	"	"	"	"	(a)
____	(b) Continuity	"	"	"	"	"	"	"	(b)
____	(c) Integration techniques	"	"	"	"	"	"	"	(c)
____	(d) Differentiation techniques	"	"	"	"	"	"	"	(d)
____	(e) Theoretical foundations, Rolle's, Mean Value, etc.	"	"	"	"	"	"	"	(e)
____	(f) Physical applications, e.g., work, etc.	"	"	"	"	"	"	"	(f)
____	(g) _____	"	"	"	"	"	"	"	(g)
____	5. Advanced Calculus	"	"	"	"	"	"	"	(5)
____	(a) Real number analysis	"	"	"	"	"	"	"	(a)
____	(b) Complex analysis	"	"	"	"	"	"	"	(b)
____	(c) Differential equatics	"	"	"	"	"	"	"	(c)
____	(d) Integral equations	"	"	"	"	"	"	"	(d)
____	(e) Vector calculus	"	"	"	"	"	"	"	(e)
____	(f) Multiple integrals	"	"	"	"	"	"	"	(f)
____	(g) _____	"	"	"	"	"	"	"	(g)
____	6. Computer Science	"	"	"	"	"	"	"	(6)
____	(a) Hardware science	"	"	"	"	"	"	"	(a)
____	(b) Programming in BASIC	"	"	"	"	"	"	"	(b)
____	(c) Programming in FORTRAN	"	"	"	"	"	"	"	(c)
____	(d) Programming in CODOL, (other) _____	"	"	"	"	"	"	"	(d)
____	(e) Numerical analysis	"	"	"	"	"	"	"	(e)
____	(f) _____	"	"	"	"	"	"	"	(f)

		7	6	5	4	3	2	1	
_____ 7.	Probability and Statistics	"	"	"	"	"	"	"	(7)
_____	(a) Permutations and combinations	"	"	"	"	"	"	"	(a)
_____	(b) Bayes Theorem	"	"	"	"	"	"	"	(b)
_____	(c) Theoretical distributions, e.g., binomial	"	"	"	"	"	"	"	(c)
_____	(d) Inferential statistics	"	"	"	"	"	"	"	(d)
_____	(e) Game theory	"	"	"	"	"	"	"	(e)
_____	(f) _____	"	"	"	"	"	"	"	(f)
_____ 8.	Symbolic Logic	"	"	"	"	"	"	"	(8)
_____ 9.	Number Theory	"	"	"	"	"	"	"	(9)
_____10.	_____	"	"	"	"	"	"	"	(10)
_____11.	_____	"	"	"	"	"	"	"	(11)

Now go back and find the TEN (10) most important of <u>all</u> the items on the questionnaire. Place 1, 2, 3...10 in the blanks before the items to rate them in order of importance to you, using 1 for the most important.

<u>COMMENTS</u>: